TITLE
Learning to Play Soccer: Lessons on Meta-cognition from Video Game Design

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Abstract

Over the past decade, there has been ongoing debate relating to the use of suitable pedagogical approaches for designing learning environments to develop skillful games players. There has, however, been little consideration of the "digital age of learning" and the global success of the digital video game industry. Using the educational work of James Gee, this paper attempts to rationalize how a "digital video games approach" differs from other learner-centered pedagogies currently employed for teaching and coaching games. Examination of the literature suggests that the learning gains from Teaching Games for Understanding (TGfU) and the Constraints Led Approach (CLA) ignore the meta-cognitive dimension of learning *how* to play games; surely an important consideration for long term development. Accordingly, by drawing on experiences from digital video game design, we examine how games practitioners might utilize such an approach for meta-cognition in coaching or teaching practice to stimulate player learning.

Key words: games, pedagogy, skill

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Introduction

Despite a recent challenge to their primacy, team games (hereafter games) have always been a central part of Physical Education (PE) and youth sport. This centrality has several components. Certainly, the social aspects of games playing make it an effective way to engage individuals towards a lifelong (or at least post school) involvement in sport and, therefore physical activity. Furthermore, games may also teach several important concepts central to education of and through the physical, in short, the fullest definition of physical literacy (Mandigo, Francis, Lodewyk, & Lopez, 2012). As mentioned above, however, games seem to have gone out of style in modern PE thinking, perhaps because the teaching of this diet staple has failed to keep pace with developments elsewhere in the school curriculum and pedagogical approach. Whether games should or should not play such a central role in a PE curriculum, our argument here is that current approaches are badly underselling this important and potentially powerful element, quite apart from the weaknesses which accrue for aspirant high level games players. After all, professional team games still play a central role in our societies!

Reflecting this potential, this paper will draw attention to the careful design of video games, and the impact this has on developing learning and performance. It will become clear why application of a “digital video games approach” that is based on meta-cognition principles may be another strategy for games practitioners to consider when developing skillful games players, while highlighting the absence in pedagogies that consider players’ meta-cognitive development. Having established the importance of cognition and meta-cognition for games players, we use the work of James Gee to examine meta-cognition in game design. This will be considered using three learning principles: deep understanding, problem solving and empowerment. Finally, application of meta-cognition in games practice will be illustrated and rationalized through soccer examples, using features from Gee's (2013) "Good Game Design" (GGD).

The Role of Meta-cognition in Games

Meta-cognition – What is it and why is it crucial for games?

Early conceptualizations of meta-cognition take the perspective of "thinking about thinking" or the self-regulation of cognitive activities during learning (Brown, 1978; Flavell, 1979). Subsequently, scientific educational research has attempted to detangle the relationship between cognition (know-about), situated cognition (know-how) and meta-cognition (know-how-to-learn), coherently expressed in an overview by Mahdavi (2014). The complexities of meta-cognition have been deconstructed further, using a components based approach to understanding how meta-cognition works in learning situations, most commonly making a distinction between meta-cognitive knowledge and meta-cognitive skills. The former refers to a person's declarative knowledge about the environment (person, task, strategy), or "self-appraisal" of personal understanding, abilities and affective state during the learning process (Paris & Jacobs, 1984). The latter to a person's procedural knowledge for engaging in problem-solving activities, or "self-management" of the problem-solving process (Paris & Jacobs, 1984). Although self-appraisal and self-management in games learning are both required to be skilled performers, meta-cognitively skilled people can more easily detect feedback mechanisms within game play, regardless of Intelligence Quotient (IQ) or task relevant strategies (Karan & Irizarry, 2014). Such mechanisms enable them to use feedback from current or previous learning activities to reconsider how they engage in future, similar activities; in other words, to demonstrate cognitive control and awareness.

The implications of such debates have led practitioners to ponder how meta-cognitive skills can be embedded in formal education for learning, teaching and assessment, and whether meta-cognitive skills should be taught implicitly or explicitly. While there have been many investigations into the ways in which meta-cognition operates in both formal and informal learning contexts since the early work of Paris and Jacobs (1984), this paper will use their definition of meta-cognition due to its' close relationship to learning in games.

Until recently, despite the importance of developing skilled games players who can learn movements in the context of a game environment being acknowledged, there has been little agreement as to how various approaches may support players' cognitive expertise. Typically, the sports coaching and PE pedagogical literature refers to various Game Centered Approaches (GCA), including Teaching Games for Understanding (TGfU) in the U.K. (Bunker & Thorpe, 1982); Game Sense in Australia (Australian Sports Commission, 1996); and Tactical Games in the U.S. (Griffin, Mitchell, & Oslin, 1997). These approaches use a tactics-skill progression focus (Hopper, 2002) and originate from a desire to develop players who can make better game decisions and execution of skills in a game context, predicated on a greater tactical understanding of games themselves. As noted by Metzler (2000), however, these models have been designed to improve game learning, yet the cognitive theory that motivated their design has not been defined.

Teaching Games for Understanding

Specifically focusing this argument around TGfU because of its longstanding presence in academic literature since the 1960's, and in response to Metzler's observation, Kirk & MacPhail (2002) have since "re-thought" the original TGfU model. Despite not being the originators of the model, they attempt to make strong links to a situated cognition perspective, to explain the contextualized interactions between the learner and game form, strategic knowledge and tactical awareness, and making appropriate game decisions. Building on Kirk & MacPhail's (2002) argument, a more recent analysis of TGfU by Tan, Chow and Davids (2012) draws upon TGfU's four pedagogical principles (sampling, tactical complexity, representation and exaggeration), to highlight theoretical and practical implications of a Nonlinear Pedagogy (NLP), whereby learning is bound within a pedagogical framework of situated learning in game contexts (Chow, 2010). This analysis employs TGfU to apply an ecological dynamics perspective (cf. Gibson, 1986) such as constraints manipulation and information-movement coupling, with perception theory at its core. In response, Renshaw et al (2016), argue that TGfU was not developed from motor control or motor learning theory, and that nor should it be linked to such theories. Instead, Renshaw and colleagues suggest that TGfU uses "operational principles" which are guided by a focus on an "understanding" of games, and how to play games, subconsciously inspired by cognitivist and constructivist concepts (most notably the work of Jerome Bruner in the 1960's).

This concept of "understanding" in games learning is specifically explored in, Almond's (2015) later work, a feature of the approach that both Renshaw et al (2016) and Almond (2015) believe has been lost in the literature. Indeed, Almond (2015) suggests that the original thinking behind TGfU was centered on developing learners' understanding of "outwitting the opposition", with the teacher or coach framed as a "quizmaster" whose primary role is to design authentic games puzzles for learners to solve. While this problem-posing and problem-solving approach lends itself to meta-cognitive player development, the original TGfU literature does not make any explicit link between the role of meta-cognition in developing understanding in games.

Constraints-Led Approach

Theories of perception and an ecological dynamics framework underpin the more recent Constraints Led Approach (CLA). This approach has similar operational intentions to TGfU, including a desire to design learner-centered and representative game forms; however, it is distinct from TGfU due to the emphasis placed on motor control theory (not cognitive theory) and the interaction between task, environment and individual learner (Newell, 1986) that facilitate perception-action coupling in situated game learning contexts (Renshaw et al, 2016). The CLA uses the theoretical and practical principles of NLP, and has been shaped by empirically driven data from ecological psychology and dynamical systems theory. In fact, the approach has received considerable attention in some areas of skill acquisition (not just games) and football coaching practice (Bartlett, 2014), with practitioners increasingly "buying in" to the concept of applying constraints to alter learner behaviors. While the theoretical underpinnings of the CLA are made clear, scholars, however, have yet to address why the ecological dynamics perspective is particularly relevant for developing skillful games players.

The call for meta-cognition in games learning

While there is no single best way to teach or coach (Metzler, 2011), TGfU and CLA are both considered possible approaches to developing in-action game play behaviors that de-emphasize technique-focused practices where skill does not transfer into a game context. Indeed, it could be argued that both TGfU and CLA scholars have largely overlooked meta-cognition development (and its translation into practice) as a fundamental theoretical principle, neglecting the tactical elements of decision making in favor of situated technique. Furthermore, the pedagogical debate within teaching and coaching games has failed to draw upon digital learning practices that *do* use meta-cognition successfully in areas including education, entertainment, business and, in particular, the digital video game industry.

We argue that if practitioners are to develop intelligent, reflective and thoughtful games players, who can cope with the dynamic and complex interactions that occur between environment, players and the task (Chow, 2013), we must widen the search beyond the pedagogy, perception and motor learning domains that have traditionally informed games practice. If we do not look to alternative and contemporary domains that are successful in using cognitive theory to develop expertise, then we will run the risk of creating a similar version of the same approach; a situation that is likely to have contributed to a misinterpretation of TGfU and other GCAs (Butler, 2014). Alternatively, if we are to understand how alternative and contemporary domains may be used to develop players' cognitive capabilities, we need to first establish the complex nature of learning itself within today's "digital age", before examining issues such as what constitutes as good learning for games players, and devising ways to apply this to practice.

Digital Games for Learning

In recent years, a range of authors in the field of video game learning design (e.g., Gee, 2003, 2007, 2013; Salen & Zimmerman (2004, 2006) have argued that video games are a space for ongoing assessment (and not just content), where players are encouraged to master their game skills through varied repetition conditions, and are therefore motivated to learn something that is "long, hard and complex", yet still enjoyable to do (Gee, 2003). The process of players' becoming particularly skilled in their know-how-to-learn meta-cognitive capabilities is not explicitly differentiated from learner-centered pedagogies for games learning in physical education and sport.

Differences are in large part by a design focus on meta-cognition development, where players need to plan their actions, check their progress, change their strategy, and evaluate their actions in the game (i.e., their “know-how-to-learn”) as opposed to the acquisition of more consistent, formulaic strategies. This lack is unfortunate since, as highlighted in the early game-centered literature (e.g., Bunker & Thorpe, 1982; Griffin, Mitchell, & Oslin, 1997; Mitchell & Griffin, 1994; Thorpe, Bunker, & Almond, 1986), game players need to “understand” game logic, primary & secondary rules and, as result, come up with novel game solutions (in attack and defense), all of which are self-directed game skills that align to the applicability of meta-cognition design. Moreover, the games learning literature highlights the complex nature of games themselves, which involve continuous interacting constraints that influence movement control in learners (Chow et al, 2009; Hopper, Sanford, & Clarke, 2009; Storey & Butler, 2013), arguably another implicit reference for skilled players requiring meta-cognitive capacities to reflect and adapt to the game situation. Nevertheless, despite the obvious relationship between games learning and meta-cognitive behaviors, this area is still under researched and overlooked in physical education and sport (Chatzipanteli, Digelidis, Karatzoglidis, & Dean, 2016).

Theories of learning for learner-centered pedagogies used for games, such as TGfU and CLA, have paid little attention to the digital domains of learning and the success these digital spaces have in using meta-cognition principles to harness learning and performance. As such, the work of James Gee would seem particularly appropriate in giving insight into understanding how digital video game design can inform pedagogies for teaching games in PE and sports coaching. Therefore, the following section focuses on the key meta-cognition concepts used by Gee for developing player learning expertise and performance in games, thus illustrating the potential for digital video game design principles to be used for future physical education and sports coaching practice. See Gee (2013, pg. 23-36) for a detailed summary of 'Good Digital Game Design Features'.

Gee's Good Digital Game Design – developing the "know how to learn"

For Gee, humans understand best when they believe information to have meaning; consequently, learning occurs when information is considered to be useful for the human to carry out a particular action, or to prepare them for a specific goal. In fact, Gee (2013) argues for the "mind as a video game", a digital analogy for the human mind and its capabilities. He suggests that humans are most effective at learning when they are creating simulated experiences in order to achieve specific goals. In the context of games, the video game provides a visual and auditory world, bound by being "goal directed" or having "win states", which are set by the gamer or the game. The game player's engagement with this "world" enables them to *consciously* recognize and utilize "affordances", which are features of the game that allow the opportunity to achieve the win state.

The ways in which the "simulated worlds" in video games are physically created involves a regular makeover in terms of graphics, sound effects, characters, weapons, tools and so on. Furthermore, in order to provide greater meaning to simulated game experiences, the look and feel of these worlds are consistently updated to provide an embodied experience for game players, which encourages players to feel immersed in their game world, and provides a sense of reality where virtual and physical worlds are merged. Immersive experiences of the game world represent the "situatedness" of learning (Gee, 2003), where the gamer develops "know-how" by becoming a part of the game itself and accepting the cultural and physical constructs of the game and how it is played. For Gee, however, good learning equals good game mechanics, as he describes (any) game as simply "problem solving spaces that are meant to engage players" (Gee, 2013, p. 104). Indeed, in video game design theory (Salen & Zimmerman, 2004, 2006), game mechanics are the internal architecture that influences how the player may act in order to solve problems. Furthermore, from Gee's perspective, good games for learning engender a desire for players to figure out how the rules of the game can be used to their advantage, which therefore engages players in reflection-on-strategy in order to achieve a win state. This is one reason games don't include an instruction manual, nor does a coach or teacher direct or shape video game play; instead, game playing is instigated by the gamer themselves, and the gamer only gets better at the game by playing itself. It is this notion that confirms the architecture of games to be unique from any other kind of formal or informal learning activities, and stems from Gee's (2007) term of "game as teacher". Such architecture embeds the meta-cognitive skills of "know-how-to-learn", and reinforces the idea of game designers as "practical theoreticians of learning" (Gee, 2013, p. 21), where careful design of games result in covert learning, often leading to performance gains.

Applying Gee's Good Digital Game Design Framework to Soccer Practice

Empowerment, Problem Solving & Deep Understanding

As part of Gee's notion of becoming a "practical theoretician of learning", the design of a "game world" is bound by three learning principles: empowerment, deep understanding and problem solving (Gee, 2007). Arguably, these principles apply to all areas of education (not just PE and sport), and particularly align to ideas of learning in the "digital age" (as characterized earlier in this paper). Reflecting this position, we now present an argument for design features that encapsulate principles of empowerment, problem solving and deep understanding. We suggest ways in which these features can be applied to soccer game design to develop soccer players who are not just skilled, but are able to *learn how* to become skilled, through playing the game. As such, we propose an alternative approach to teaching and coaching games, one where meta-cognitive development is placed at the heart of game design, an aspect of learning that has not yet influenced theory and/or practice for game centered pedagogies such as TGfU, nor skill acquisition learning design, such as in CLA.

Enabling Meta-Cognition: Designing a game world

Building on the video game concept of "game as teacher" (Gee, 2007) which was later applied in PE and sports coaching (Hopper, Sanford, & Clarke, 2009), and borrowing the more up to date notion of "thinking like a game developer" (Pill, 2014; Pill, Price, & Magias, 2017), the challenge for PE and sports coaching practitioners is to firstly consider soccer practice as a "game world" rather than a subject matter, sport, or opportunity to convey content. Therefore, a change from traditional modes of thinking about lesson planning and game design is required, not least a move away from "what will we be learning today" to "this is today's mission".

[insert figure 1]: Soccer as a Game World

[insert figure 2]: Soccer as a Game World

What's the Mission?

According to Gee (2007), human beings tend to associate learning with work, and this is one reason video games are so successful in getting people to enjoy learning. For example, by using the popular, mobile application game "Mario Bro's Go" to theme physical and imaginary make-up of the game world, players are able to quickly identify with the "mission", thereby masking the formal learning process. In the example of figure 1, the mission is related to three of Wade's (1967) phases of play: the "attacking" phase, whereby players are required to use possession of the ball in order to collect coins; the "defending" phase, whereby players are required to limit the number of coins collected by the opposition; and the "transition" phase, whereby players are required to react instinctively to moments of re-gaining, or losing possession. For this design, individual players (and the team) earn coins by receiving the ball from a teammate. In practice, coins may represent small stickers that are placed around the side of the playing area for players to retrieve.

Since the early work of Wade (1967), phases of play for invasion games have been central to the use of small sided games to develop skill acquisition and, more recently, used as a central foundation for game centered pedagogies such as TGfU. By assuming a broad focus, where phases of play are considered interconnected and interdependent (rather than a narrow skill focus), players become "active agents" through the ways in which they interact with the mission, rather than "passive consumers" (Gee, 2007). Consequently, the ways in which the player responds to the mission will depend on what the player practices and learns in the game, and this will be different for each player, and both teams.

Using the Pause Button

Coaches and teachers are inclined not to focus on a narrow, "know-what" or "know how" perspective of learning due to the broad spectrum of attacking-defending and defending-attacking play that will occur in game play for each player. Instead of coaches and teachers thinking "what can I do to challenge player understanding of when, why or how to pass quickly", thinking shifts towards "how are players responding to the mission?" As a result, the role of the practitioner is not to interrupt play with an intervention (such as an open or closed question), unlike game centered approaches, which consider practitioner questioning as a key characteristic of learner-centered games teaching (Harvey, Cope, & Jones 2016). Instead, the practitioner's role during game play is to observe where possible and be prepared to respond to the player(s) when they decide to "pause" the game, thus negating the notion of "game as teacher" in PE and sports coaching (Hopper, Sanford, & Clarke, 2009), which implies the practitioner's sole responsibility is to modify the game through representation, exaggeration or adaptation principles (Hopper, 2011). Therefore, the coach or teacher "thinking like a game developer" (Pill, 2014; Pill, Price, & Magias, 2017) is considered as a more relevant term considering that players may decide to interact with the coach when the game is paused. This term illustrates the interactivity of digital games, which Gee (2013) explains are bound by ongoing episodes of the player reacting, and the game (or game developer) reacting back. These interactive episodes include opportunities for players to pause for cheats, collaboration, clues or challenges (the 4 C's) (see figure 1 & figure 2), depending on the amount and type of support they think are required. Teams or individual players may initiate the 'pause' at any time in the game, though the practitioner ought to apply professional judgment to structure frequency/timing of 'pauses' so not to disrupt flow of gameplay. This placing of onus on the player(s) to pause the game amplifies the meta-cognitive game skills of "I need help with this" or "we need to alter how we do this", considered in previous game centered literature (cf. Light, Harvey, & Mouchet, 2014) where the space and time a player has dictates whether game decisions are reflexive or subjective. For example (see figure 1), "O team" is playing on Level 3, and experiencing a problem that is too difficult to solve (opposition are defending deep and denying space near the goal area). When the game is paused, "O team" decides to "cheat" by taking a player from the opposition team because an extra player is likely to open up space. This is an example of players self-managing the problem-solving process and therefore developing their “know-how-to-learn” capabilities.

Level-Up!

As the game moves from its simplest form (a term of complexity, also used in TGfU’s pedagogical principles) to a more complex form, players experience the opportunity to “level up”. In short, leveling up in digital games demonstrates a player’s competency at performing variations of a specific skill or set of skills. This is typically where assessment is carefully woven into game design, resulting in an explicit approach to understanding both learning and performance, which goes against the grain of implicit and learner-centered pedagogies used for games.

The academic literature on assessment in physical games (e.g., Gray & Sproule, 2011; Grehaigne, Godbout, & Bouthier, 1997; Grehaigne, Richard, & Griffin, 2005; Oslin, Mitchell, & Griffin, 1998) evidences a dearth of debate and ideas on how best to assess game performance and understanding, perhaps due to the complex tactical-technical nature of games themselves (Memmert & Harvey, 2008). This is coupled with the conflict of determining the “know about” and “know how” of games. In essence, by using a level-up design approach to games, the focus of assessment shifts away from narrow skill components towards an assessment of meta-cognitive skills that inherently require the player to learn and master a skill or set of skills. Typically, in response to the notion of “leveling up”, players are thinking “how can I get to the next level”, rather than “how do I get better at passing to a team mate”. As a result, players learn to practice skills, which are part of the wider strategy to accomplish the game’s overall mission.

Earning a Super Power

As players move through the game on a “coin collecting mission” (see figure

1), they are rewarded with a “super power” each time their team scores a goal. This is important for the logic of invasion games, as their purpose is ultimately to invade the opponent’s space in order to score a point/goal (Wade, 1967). Therefore, game designers should be careful that the game’s design does not discourage logical play (both in attack and defense).

As this particular example (figure 1) uses a Mario Bro’s Go theme, it therefore adopts some of the graphics and concepts associated with this brand of video game. People who have previously played Mario Bro’s games will recognize these graphics (such as the red shell icon), and value ways in which this power can help them to be more effective in the game. In Super Mario Bro’s, a red shell signifies the opportunity to “wipe out” an opponent (for a temporary period of time). Digital video game designers and scholars describe such super powers as “smart tools” (Salen & Zimmerman, 2004, 2006), and Gee (2007, 2013) views smart tools as a form of game design manipulation that enables players to feel a greater sense of empowerment. By providing players the opportunity to earn rewards (temporary super powers), players are motivated to exploit ways in which they can use their newfound effectiveness. Earning and using a power, therefore, enables the game to be explored from a new perspective, a perspective that was not possible to be explored without the power. This element of video game design gets players thinking “anything is possible”, and “nothing is certain”.

The application of a “red shell” power in figure 1 is to “choose an opposition player to lock in one area of the pitch”, with this power lasting for 60 seconds. The outcome of this design results in temporary underload and overload situations, which challenge both teams to consider different ways in which they might approach the game’s mission. For the team with the power, their thought may be “how can we use this power to collect more coins?", while the team without the power might be thinking "how do we minimize the number of coins the opposition collects?" Due to the short-term nature of super powers, players are required to adapt and react to out of balance situations quickly, while considering the game's overall mission.

Saving Progress

Some of the early work on TGfU centered around cognitive and social-constructivism although, as explained earlier in this paper, the TGfU model was not explicitly theorized. More recently, Almond (2015) used a "Bruner" perspective, whereby the concept of "scaffolding learning" through a "spiral curriculum" is employed, during which complex concepts are taught using an initially simplified version, and complexity is gradually enhanced using carefully designed and well-ordered tasks. The intention of a spiral curriculum is to develop learners who can solve potentially complex problems by themselves. The spiral curriculum concept can also be compared to a video game and the ways in which video game design facilitates enjoyable learning of something that is "long, hard and complex" (Gee, 2003). Notably, however, in video games players always have the opportunity to save their learning progress. This means that players have a clear point at which they end the game and begin a new game, advocating player progress as a means to pace learning, rather than ticking off technical or tactical content.

This saving of progress in video games is known as a "risk alleviating" design (Gee, 2007), whereby players are inclined to take risks in game play because they understand their progress will not be diminished if a mistake is made. For example, when losing a life in the game Mario Bro's Go, the player re-starts the game from the point at which he/she "died". This principle is applied in figure 1, whereby this particular game could be played multiple times, with individual players/teams each ending and beginning the game at different points (dictated by how many coins are collected). Players and teams in the game therefore experience challenge that is "hard but doable, and effort is paying off" (Gee, 2013). Having this "safe haven" for game play is very important for learning complex concepts, as players feel like they can independently explore multiple solutions to game problems, reducing fear of failing and appreciating that failure is needed for learning.

Conclusion

Based upon our review of empirical work concerning learning in the "digital age", for the "games generation" (Prensky, 2000), we believe that digital video game design has the potential to positively influence meta-cognitive development of soccer players. While learner-centered pedagogical approaches used for soccer have tended to focus on know-how of game play, it seems that the theoretical basis for such approaches have failed to consider how practitioners might use game design to develop the "know-how-to-learn", so that players are prepared to become autonomous games players. Yet, without purposeful meta-cognitive design for soccer practice, players have a narrow skill-focused initiation into the game, rather than a broad learning focused initiation. Therefore, current coaching and teaching practice for soccer fails to educate players using methods that might help them to influence their own learning, and across various domains. The challenge is not to ignore the place for learner-centered pedagogies, such as TGfU and CLA but rather, to extend upon their "know how" design and move it into the realms of "know-how-to-learn"; in short, a more cognitive and meta-cognitive approach. Clearly, there is a need to explore how Gee's (2013) GGD can be translated into game design for soccer, and to establish the position of the coach-as-designer when using a digital video game approach. This means that coaches and teachers should experiment with meta-cognitive design, and ways in which this transfers onto the pitch with players. Our position, therefore, is that coaches and teachers should consider how they are facilitating opportunities for players to become autonomous games players, where opportunities to develop meta-cognition are at the heart of game design, rather than the development of sport-specific skills in game contexts, albeit that this latter approach is a significant step forwards on the use of technique isolated, low fidelity drills. The meta-cognition approach would give players a greater opportunity to develop game related learning skills, which in turn help them to thrive in the dynamic context of a game.

We believe that the coaching and teaching pedagogical landscape for soccer (and invasion games more broadly) needs to explore new ways of developing skilled players, and to be less concerned with breaking down technical/tactical game components as a means to guide game design and interventions. What we propose is the beginning of a new approach to teaching and coaching games, known as the "digital video games approach", which is aligned to learning in the digital age and meeting the expectations of the games generation of players. We appreciate this approach is currently a concept based upon theory, and so we urge practitioners to explore its application in order to inform practice with an evidence base. Just as with any digital tool, we believe this approach has scope for practitioners to develop their own "software", individual to their context, but set within Gee's GGD "hardware" of learning principles. Such an approach could serve to bridge the gap between informal digital worlds and formal non-digital worlds, where players become "active agents" rather than "passive consumers" in their soccer learning. Finally, this approach will likely require a deep philosophical shift in practitioners' perspectives of what learning is, and how it happens, in organized soccer contexts.

References

Almond, L. (2015). Rethinking teaching games for understanding. *Ágora para la Educación Física y el Deporte, 17(1),* 15-25.

Australian Sports Commission. (1996). Game sense: Perceptions and actions research report. Belconnen, ACT: Australian Sports Commission.

Bartlett, B. (2014). A framework for practice design. *The Football Association Bootroom Magazine, 10,* 22-31.

Brown, J. S. (1978). Knowing when, where, and how to remember: A problem of metacognition. In R. Glaser (Ed.), *Advances in instructional psychology,* (pp. 77–165). Hillsdale: Erlbaum.

Bunker, D. J., & Thorpe, R. D. (1982). A model for the teaching of games in secondary schools. *The Bulletin of Physical Education*, *18*, 1.

Butler, J. (2014). TGfU – Would you know it if you saw it? Benchmarks from the tacit knowledge of the founders. *European Physical Education Review*, *20(4),* 465-488.

Chatzipanteli, A., Digelidis, D., Karatzoglidis, C., & Dean, R. (2016). A Tactical-game approach and enhancement of metacognitive behaviour in elementary school students. *Physical Education and Sport Pedagogy, 21(2),* 169-184.

Chow, J. I., Davids, K.W., Button, C., Renshaw, I., Shuttleworth, R., & Uehara, L. A. (2009). *Nonlinear pedagogy: Implications for teaching games for understanding (TGfU).* In Hopper, T., Butler, J., & Storey, B. (Eds.) *TGfU...Simply good pedagogy: Understanding a complex challenge,* (pp. 131-143). Ottawa, Canada: Physical Health Education Association.

Chow, J. Y. (2010). Insights from an emerging theoretical perspective in motor learning for physical education. In M. Chia & J. Chiang (Eds.) *Sport Science* *in the east: Reflections, issues and emergent solutions* (pp. 59–78). Taiwan: World Scientific.

Chow, J. Y. (2013). Nonlinear learning underpinning pedagogy: Evidence, challenges and implications. *Quest*, *65*, 469–484.

Flavell, J. H. (1979). Metacognition and cognitive monitoring. *American Psychologist, 34(10)*, 906–911.

Gee, J. P. (2003). *What video games have to teach us about learning and literacy*. New York, NY: Palgrave Macmillan.

Gee, J. P. (2007). *Good video games and good learning (New literacies and digital epistemologies).* New York, NY: Peter Lang Publishing, Inc.

Gee, J. P. (2008). Learning and Games. In K. Salen & The John D. and C. T. MacArthur Foundation (Eds.), *The ecology of games: Connecting youth, games, and learning*. Cambridge, MA: The MIT Press.

Gee, J. P. (2013). *Good video games and learning*. New York, NY: Peter Lang Publishing Inc.

Gibson, J. J. (1986). *The ecological approach to visual perception*. Boston, MA: Houghton Mifflin.

Gray, S., & Sproule, J. (2011). Developing pupils' performance in team invasion games. *Physical Education and Sport Pedagogy, 16(1)*, 15–32.

Grehaigne, J. F., Godbout, P., & Bouthier, D., (1997). Performance assessment in team sports. *Journal of Teaching in Physical Education, 16*, 500-516.

Grehaigne, J. F., Richard, J. F., & Griffin, L. L. (2005) *Teaching and learning team sports and games*. New York, NY: Taylor and Francis.

Griffin, L. L., Mitchell, S. A., & Oslin, J. L. (1997). *Teaching sport concepts and skills: A tactical games approach*. Champaign, IL: Human Kinetics.

Harvey, S., Cope, E., & Jones, R. (2016). Developing questioning in game-centred approaches. *Journal of Physical Education, Recreation & Dance*, *87(3)*, 28-35.

Hopper, T. (2002). Teaching games for understanding: The importance of student emphasis over content emphasis. *Journal of Physical Education, Recreation & Dance, 73(7)*, 44–48.

Hopper, T. (2011). Game-as-teacher: Modification by adaptation in learning. *Asia-Pacific Journal of Health, Sport and Physical Education, 2(2),* 3–21.

Hopper, T., Sanford, K., & Clarke, A. (2009). Game-as-teacher and game-play: Complex learning in TGfU and videogames. In T. Hopper, J. Butler & B. Storey (Eds.). *TGfU...simply good pedagogy: Understanding a complex challenge* (pp. 201-212). Ottawa, Canada: Physical Health Education Association.

Karan, E. P., & J., Irizarry (2014). Effects of Meta-cognitive strategies on problem solving ability in construction education. Proceedings of the 50th Annual International Conference of the Associated Schools of Construction (ASC), USA.

Kirk, D., & MacPhail, A. (2002). TGfU and situated learning. *Journal of Teaching in Physical Education, 21(2),* 177-192.

Launder, A. (2001). *Play practice: The games approach to teaching and coaching sport*. Adelaide: Human Kinetics.

Light, R. (2008). Complex learning theory - Its epistemology and its assumptions about learning: Implications for physical education. *Journal of Teaching in Physical Education, 27(1)*, 21-37.

Light, R., Harvey, S., & Mouchet, A. (2014). Improving ‘at-action’ decision-making in team sports through a holistic coaching approach. *Sport, Education and Society*, *19(3)*, 258-275.

Mahdavi, M. (2014). An Overview: Metacognition in education. *International Journal of Multi and Disciplinary Research, 2,* 529-539.

Mandigo, J., Francis, N., Lodewyk, K., & Lopez, R. (2012). Physical literacy for educators. *Physical Education and Health Journal*, *75(3)*, 27–30.

Memmert, D., & Harvey, S. (2008). The game performance assessment instrument (GPAI): Some concerns and solutions for further development. *Journal of Teaching in Physical Education*, *27*, 220-240.

Metzler, M. (2011). *Instructional models for physical education*. Scottsdale, AZ: Holcomb Hathaway.

Mitchell, S.A., & Griffin, L.L. (1994). Tactical awareness as a developmentally appropriate focus for the teaching of games in elementary school. *Physical Educator, 51(1)*, 8-29.

Newell, K. M. (1986). Constraints on the development of coordination. In M. G. Wade & H. T. A. Whiting (Eds.) *Motor development in children: Aspects of coordination and control* (pp. 341–360). Dordrecht: Martinus Nijhoff.

Oslin, J. L., Mitchell, S. A., & Griffin, L. L. (1998). The game performance assessment instrument (GPAI): Development and preliminary validation. *Journal of Teaching in Physical Education*, *17*, 231-243.

Paris, S. G., & Jacobs, J. E. (1984). The benefits of informed instruction for children's reading awareness and comprehension skills. *Child Development, 55,* 2083–2093.

Pill, S. (2014). What does it mean for pedagogy to think like a game developer? *Journal of Physical Education, Recreation and Dance*, *85(1)*, 9-15.

Pill, S., Price, A., & Magias, T. (2017). Game design fundamentals and sport coaching. *Ágora para la Educación Física y el Deporte, 19(1),* 19-34.

Prensky, M. (2001). *Digital game-based learning*. St Paul, MN: McGraw-Hill Education.

Renshaw, I., Araujo, D., Button, C., Chow, J. Y., Davids, K., & Moy, B. (2016). Why the constraints-led approach is not teaching games for understanding: A clarification. *Physical Education and Sport Pedagogy, 21(5),* 459-480.

Salen, K., & Zimmerman, E. (2004). *Rules of play: Game design fundamentals*. Cambridge, MA: The MIT Press.

Salen, K., & Zimmerman, E. (2006). *The game design reader: A rules of play anthology*. Cambridge, MA: The MIT Press.

Salen, K. (2008). *“Toward an ecology of gaming." The ecology of games: Connecting youth, games, and learning.* The John D. & Catherine T. MacArthur Foundation on Digital Media and Learning. Cambridge, MA: The MIT Press.

Salen, K., Torres, R., Wolozin, L., Rufo-Tepper, R., & Shapiro, A. (2011). *Quest to learn: Developing the school for digital kids*. Cambridge, MA: The MIT Press.

Storey, B., & Butler, J. (2013). Complexity thinking in P.E: game-centred approaches, games as complex adaptive systems, and ecological values. *Physical Education and Sport Pedagogy, 18(2),* 133-149.

Tan, C. W. K., Chow, J. Y., & Davids, K. (2011). How does TGfU work? Examining the relationship between learning design in TGfU and a nonlinear pedagogy. *Physical Education and Sport Pedagogy, 17(4),* 331-348.

Thorpe, R. D., Bunker, D. J., & Almond, L. (1986). *Rethinking games teaching.* Loughborough University of Technology.

Wade, A. (1967). *The F.A. guide to training and coaching*. London: Heinemann.